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(71) Applicant: 000002185
Sony Corporation
6-7-35 Kitashinagawa, Shinagawa-ku, Tokyo
(72) Inventor: Kazuto SHIMODA
c/o Sony Corporation
6-7-35 Kitashinagawa, Shinagawa-ku, Tokyo
(74) Representative: 100067736
Patent Attorney Akira KOIKE (and two others)
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(54) [Title of the Invention]
Organic Electroluminescence Element
(57) [Abstract]
[Problem to be Solved] To provide an organic EL element which is light and excellent in durability, having flexibility and impact resistance, and capable of preventing the deterioration of an organic EL layer.

[Means for Solving the Problem] A first electrode 3, an organic electroluminescence layer 9 having a light-emitting material made of an organic compound, and a second electrode 7 are provided on a substrate 2 in this order. The substrate 2 is formed of a film-like plastic substrate, and the first electrode 3 is made of nitride and has translucency.

[Scope of Claims]

[Claim 1] An organic electroluminescence element having a first electrode, an organic electroluminescence layer having a light-emitting material made of an organic compound and a second electrode on a substrate in this order, wherein:

the substrate is a film-like plastic substrate; and

the first electrode is an electrode made of nitride and has translucency.

[Claim 2] An organic electroluminescence element according to claim 1, wherein the nitride is made of TiN.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to an organic electroluminescence (organic EL) element used as a display element, a light-emitting element or the like.

[0002]

[Prior Art] An electroluminescence element (hereinafter called EL element) is an element which is excited by applying an electric field to a fluorescent compound so as to emit light. Since the EL element is self-luminous, it has high visibility. In addition, it is a complete solid state component, so that it has features such as excellence in impact resistance. Therefore, various EL elements using inorganic or organic compounds as a light-emitting material have been researched and developed. Such EL elements can be divided into an inorganic EL element and an organic EL element, depending on the fluorescent compound used.

[0003] As for an organic EL element, electrons and holes are injected from the outside, they are recombined in a light-emitting layer made of an organic compound, and a luminescence center is excited by the recombination energy of that time. Furthermore, an organic EL element is operated with a direct current and driven with a much lower voltage, compared to an inorganic EL element. Furthermore, it has a sandwich structure, sandwiching the light-emitting layer and the carrier transporting layer between electrodes of an anode and a cathode. Therefore, by making at least one of the electrodes transparent, sheet-like luminous body can be obtained.

[0004]

[Problems to be Solved by the Invention] For an organic EL element, a glass substrate is conventionally used as the substrate. However, a glass substrate is heavy in weight, and easily broken by a shock from the outside, such as fall. That is, it has a defect that it is fragile. In addition, when considering that an organic EL element will be used in various fields by future developments, an organic EL element which is light, having flexibility and impact resistance strong to a shock from the outside, is desired.

[0005] In addition, for an organic EL element, a material whose work function from the vacuum level of the electrode material is large so that holes are injected efficiently, or a material having translucency so that organic electro luminescence is obtained from the anode side is used as an anode material to structure the anode. And especially oxides such as ITO and SnO_2 are widely used from the standpoint of production efficiency or the like.

[0006] However, when these oxides such as ITO are used as the anode material, oxygen and indium in the anode material are likely to penetrate and diffuse in the organic EL layer from the interface between the organic EL layer and the anode. And in the case where oxygen and indium penetrate and diffuse in the organic EL layer, the organic EL layer deteriorates due to the oxygen and indium. As a result, because of the deterioration of the organic EL layer, durability of the organic EL element is likely to decrease.

[0007] Therefore, the present invention is made in view of the above-described conventional circumstances, and the object of the present invention is to provide an organic EL element which is light and excellent in durability, having flexibility and impact resistance, and capable of preventing the deterioration of an organic EL layer.

[0008]

[Means for Solving the Problem] The organic EL element of the present invention has a first electrode, an organic electroluminescence layer (hereinafter called organic EL layer) having a light-emitting material made of an organic compound and a second electrode on a substrate in this order, and the substrate is a film-like plastic substrate, and the first electrode is an electrode made of nitride and has translucency.

[0009] The organic EL element of the present invention uses a film-like plastic substrate as the substrate. In this way, this organic EL element is much lighter, compared to an organic EL element using a conventional glass substrate.

[0010] In addition, since this organic EL element uses a film-like plastic substrate having flexibility, the organic EL element itself has flexibility. Since the organic EL element has flexibility, when various devices are structured using this organic EL element, when a display or the like is structured, for example, various types of usage

such as being stored in a state of rolled up can be realized.

[0011] Furthermore, using a film-like plastic substrate excellent in impact resistance against a shock such as fall, compared to a glass substrate, this organic EL element is excellent in impact resistance.

[0012] In addition, since this organic EL element uses nitride as the anode material, there is no penetration and invasion of oxygen and indium in the organic EL layer from the anode material. Therefore, the organic EL layer doesn't deteriorate by penetration and invasion of oxygen and indium in the organic EL layer from the anode material.

[0013]

[Embodiment] Hereinafter the present invention will be described with reference to drawings.

[0014] Fig. 1 is a substantial part cross-sectional view showing an example of an organic electroluminescence element (hereinafter called organic EL element) applying the present invention.

[0015] An organic EL element 1 is structured by a film-like plastic substrate 2, a first electrode 3 as an anode formed on the film-like plastic substrate 2, an organic EL layer 9 formed on the anode which is the first electrode 3, a second electrode 7 as a cathode formed on the organic EL layer 9, a protecting layer 8 formed so as to cover the cathode which is the second electrode 7 and the organic EL element 1.

[0016] The film-like plastic substrate 2 is a support for the organic EL element 1, and each layer to structure the organic EL element 1 is formed on this film-like plastic substrate 2.

[0017] Using the film-like plastic substrate 2 as the substrate, this organic EL element 1 is much lighter than an organic EL element using a conventional glass substrate. In this way, when various devices are structured using the organic EL element 1, in the case where a large display or the like is structured, for example, the device can be lighter and freedom of device design can be increased.

[0018] In addition, since this organic EL element 1 uses the film-like plastic substrate 2 having good flexibility as the substrate, the organic EL element 1 itself has flexibility. That is to say, since this organic EL element 1 uses the film-like plastic substrate 2 as the substrate, unlike in the case of using a conventional glass substrate or the like, the organic EL element 1 can have good flexibility due to the flexibility of the film-like plastic substrate 2 itself. Furthermore, using the film-like plastic substrate 2 as the substrate, the organic EL element 1 has good flexibility, so that when various devices are structured using this organic EL element 1, when a display or the like is structured, for example, various types of usage such as being stored in a state of rolled up can be

realized.

[0019] Furthermore, the film-like plastic substrate 2 is not fragile like a glass substrate, and doesn't show brittleness. Therefore, the organic EL element 1 using such film-like plastic substrate 2 is not easily broken by a shock from the outside such as fall, as an organic EL element using a conventional glass substrate is, and its impact resistance against a shock from the outside can be greatly improved.

[0020] As a material used for the film-like plastic substrate 2, polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyether sulfone (PES), polyolefin (PO) and the like, for example, can be used suitably. A material used for the film-like plastic substrate 2 is not limited to these materials, and any material that is transparent, and has good optical characteristics may be used.

[0021] It is preferable that the thickness of the film-like plastic substrate 2 is in a range of 50 μm to 500 μm. This is because it is difficult for the film-like plastic substrate 2 itself to keep its sufficient flatness in the case where the thickness is less than 50 μm, and it is likely to be difficult that good flatness of the organic EL element 1 is kept when structuring the organic EL element 1. In addition, in the case where the thickness of the film-like plastic substrate 2 is more than 500 μm, it is difficult to bend the film-like plastic substrate 2 itself freely. That is, flexibility of the film-like plastic substrate 2 itself becomes poor, and when the organic EL element 1 is structured, flexibility of the organic EL element 1 decreases.

[0022] As an anode material used for the first electrode 3 which is an anode, it is preferable that a material whose work function from the vacuum level of the electrode material is large so that holes are injected efficiently, or a material having translucency so that organic electro luminescence can be obtained from the anode side is used. As such materials, oxides such as ITO and SnO_2 are widely used. However, when the anode material includes oxygen and indium, the oxygen and indium are likely to penetrate and diffuse in the organic EL layer 9 from the interface between the organic EL layer and the anode. And in the case where oxygen and indium penetrate and diffuse in the organic EL layer 9, the organic EL layer 9 deteriorates due to the oxygen and indium, and because of that, durability of the organic EL element 1 is likely to decrease. Therefore, it is preferable that oxygen and indium are not included in the anode material structuring the anode, when possible.

[0023] Then, the organic EL element 1 uses nitride as a material for the anode which is the first electrode 3. In this specification, nitride means a nitrogen compound which does not include oxygen and indium.

[0024] By using nitride as the anode material, oxygen and indium do not exist in the

anode material, and there is no possibility that the oxygen and indium in the anode material penetrate and diffuse in the organic EL layer 9 from the interface between the organic EL layer 9 and the anode, as described above. Since a phenomenon in which oxygen and indium in the anode material penetrate and diffuse in the organic EL layer 9 to deteriorate the organic EL layer 9 does not occur, durability of the organic EL element 1 does not deteriorate because of the deterioration of the organic EL layer 9. That is to say, by using nitride as the anode material, durability of the organic EL element 1 does not decrease due to oxygen and indium in the anode material, and the organic EL element 1 is excellent in durability.

[0025] TiN is an example of nitride that can be used as such anode material. When TiN is used as the anode material, durability of the organic EL element 1 can be improved, because TiN has good adhesiveness to a film-like plastic substrate, polyethylene terephthalate (PET) for example, and is hardly removed from the film-like plastic substrate 2. The nitride is not limited to this, and any material having translucency and whose work function from the vacuum level of the electrode material is large may be used.

[0026] It is preferable that the thickness of the anode described above is in a range of 3 nm to 10 nm. This is because when the thickness of the anode is less than 3 nm, the thickness is too thin and the anode does not function sufficiently. When the thickness of the anode is more than 10 nm, transmittance of visible light is reduced, which makes it unsuitable for practical use.

[0027] The organic EL layer 9 is provided with a hole transporting layer 4, a light-emitting layer 5 and an electron transporting layer 6, and each of these layers is formed on the anode in this order to structure the organic EL layer 9.

[0028] The hole transporting layer 4 transports holes injected from the anode to the light-emitting layer 5. Benzine, styrylamine, triphenylmethane, porphyrin, triazole, imidazole, oxadiazole, polyaryl alkane, phenylenediamine, arylamine, oxazole, anthracene, fluorenone, hydrazone, stilbene, or a derivative of these, heterocyclic conjugated monomer, oligomer, polymer such as polysilane compound, vinyl carbazole compound, thiophene compound and aniline compound are examples of materials which can be used as the hole transporting material.

[0029] Specifically, α-naphthyl phenyl diamine, porphyrin, metal tetraphenylporphyrin, metal naphthalocyanine, 4, 4', 4" -trimethyl triphenylamine, 4, 4', 4" -tris (3-methylphenyl phenylamino) triphenylamine) triphenylamine, N, N, N', N', -tetrakis (p-tolyl) p-phenylenediamine, N, N, N', N', -tetraphenyl4, 4' -diaminobiphenyl, N-phenyl carbazole, 4-di-p-tolylaminostilbene, poly (paraphenylenevinylene), poly

(thiophenevinylene), poly (2, 2', -thienylpyrrole) and the like are examples, but not limited to these.

[0030] In the light-emitting layer 5, an electron and a hole are combined to each other and the binding energy is emitted as light. Although the light-emitting layer 5 is provided independently in Fig. 1, a hole transporting light-emitting layer which functions as the hole transporting layer 4 and the light-emitting layer 5 both, and an electron transporting light-emitting layer which functions as the electron transporting layer 6 and the light-emitting layer 5 both may be used. When the hole transporting light-emitting layer is used, a hole injected from the anode to the hole transporting light-emitting layer is confined by the electron transporting layer, and the recombination efficiency is improved. When the electron transporting light-emitting layer is used, an electron injected from the cathode to the electron transporting light-emitting layer is confined within the electron transporting light-emitting layer, and the recombination efficiency is improved in the same way as the case of using the hole transporting light-emitting layer.

[0031] As a material for the light-emitting layer 5, organic materials such as a low molecular fluorochrome, a fluorescent polymer, a metal complex, meeting the following conditions: a hole can be injected from the anode side and an electron can be injected from the cathode side when a voltage is applied; the injected charge, that is, the hole and the electron can be moved and a place where the hole and the electron are recombined can be provided; the light-emitting efficiency is high; and the like.

[0032] Anthracene, naphthalene, phenanthrene, pyrene, chrysene, perylene, butadiene, coumarin, acridine, stilbene, tris (8-quinolinolato) aluminum complex, bis (benz quinolinolato) beryllium complex, tri (dibenzoylmethyl) phenanthroline europium complex, ditoluylvinylbiphenyl and the like are examples of these materials.

[0033] The electron transporting layer 6 transports electrons injected from the second electrode 7 which is a cathode to the light-emitting layer 5. Quinoline, perylene, bis styryl, pyrazine, or derivatives of these are examples of the material that can be used as a material for the electron transporting layer 6.

[0034] Specifically, 8-hydroxyquinoline aluminum, anthracene, naphthalene, phenanthrene, pyrene, chrysene, perylene, butadiene, coumarin, acridine, stilbene, or derivatives of these are the examples.

[0035] As a material used for the second electrode 7 which is the cathode, it is preferable to use a metal whose work function from the vacuum level of the electrode material is small so that electrons are injected efficiently.

[0036] Specifically, low work function metals such as aluminum, indium, magnesium,

silver, calcium, barium and lithium may be used as an elementary substance, or these metals may be used combined with other metals to make an alloy so as to improve the stability.

[0037] The protecting layer 8 seals the organic EL element 1 and shuts out oxygen and moisture so that reliability of driving of the organic EL element 1 is ensured and deterioration of the organic EL element 1 is prevented. As a material used for the protecting layer 8, metal elements which can keep airtightness and transmit light generated in the light-emitting layer 5, or the alloy of them and the like may be used selected accordingly. It is preferable that the protecting layer 8 is formed so as to cover the organic EL element 1 as a whole, as shown in Fig. 1, not only the cathode. By forming the protecting layer 8 so as to cover the organic EL element 1 as a whole, invasion of oxygen and moisture from the outside into the organic EL element 1 can be prevented.

[0038] Specifically, aluminum, gold, chromium, niobium, tantalum, titanium, silicon oxide or the like are the examples.

[0039] In addition, each layer to structure the above-described organic EL element 1 may have a laminated structure formed of a plurality of layers respectively.

[0040] As described above, the organic EL element 1 structured as above uses the film-like plastic substrate 2 as the substrate, so that it can be much lighter than an organic EL element using a conventional glass substrate.

[0041] In addition, this organic EL element 1 uses the film-like plastic substrate 2 having good flexibility as the substrate, therefore the organic EL element 1 itself has good flexibility.

[0042] In addition, this organic EL element 1 uses the film-like plastic substrate 2 which is excellent in impact resistance against a shock such as fall, therefore the impact resistance can be improved greatly.

[0043] Furthermore, this organic EL element 1 uses nitride as the anode material, so that there is no penetration and invasion of oxygen and indium in the organic EL layer 9 from the anode material, and the organic EL layer 1 doesn't deteriorate due to the oxygen and indium.

[0044] As for the organic EL element 1 structured as above, by applying a direct-current voltage between the anode and the cathode selectively, holes which are injected from the anode move through the hole transporting layer 4 and electrons which are injected from the cathode move through the electron transporting layer 4, and they reach the light-emitting layer 5 respectively. As a result, recombination of electrons and holes arises in the light-emitting layer 5, and light emission of the predetermined

wavelength is generated from here. In addition, by selecting the materials of the light-emitting layer 5, an organic EL element for full color or multi color, emitting three colors of R, G and B can be made. The organic EL element 1 can be used for a display, for example, and besides, it can be used as a light source or the like, and it can be used for various optical applications.

[0045] The organic EL element 1 described above can be manufactured as follows.

[0046] First, a film-like plastic substrate 2 formed of PET whose thickness is 50 μm, for example, is prepared as the substrate, and a first electrode 3 which is the anode whose thickness is 10 nm, for example, is formed on the main surface of the film-like plastic substrate 2 by reactive DC sputtering.

[0047] As for the organic EL element 1, using the film-like plastic substrate 2 as the substrate, the substrate temperature cannot be high, when a TiN film which is the anode is formed. This is because the substrate is the film-like plastic substrate 2 which melts when the substrate temperature is heightened. Therefore, as for the organic EL element 1, it is necessary to set the substrate temperature around room temperature of approximately 30 to 70 °C when the TiN film as the anode is formed.

[0048] In addition, it is required that the TiN film as the anode has low resistivity of approximately 1×10^{-4} to 2×10^{-4} Ω cm and visible light average transmissivity of approximately 50 to 80 %. In order to form a TiN film meeting such requirements, it is necessary to raise the substrate temperature when forming the film, conventionally.

[0049] And so, in order to form a TiN film meeting the above-mentioned requirements and having favorable characteristics, the TiN film of the organic EL element 1 is formed by reactive DC sputtering. By using reactive DC sputtering, it becomes possible to form the TiN film with the substrate temperature around room temperature of approximately 30 to 70 °C. In addition, by using reactive DC sputtering, it becomes possible to obtain a TiN film excellent in resistivity and visible light average transmissivity. Furthermore, with reactive DC sputtering, the film forming speed can be raised greatly by applying high electric power of approximately 7 kW, for example, so that a TiN film can be formed efficiently.

[0050] For example, when a TiN film with the film thickness of 10 nm is formed on a film-like plastic substrate, under the condition of the applied electric power 7 kW and the substrate temperature room temperature, using Ar and N_2 as the sputtering gas, a TiN film having favorable characteristics of resistivity 2.3×10^{-4}, visible light average transmissivity approximately 70 % is obtained.

[0051] In Fig. 2, the characteristics concerning resistivity and absorption coefficient of a TiN film formed on a film-like plastic substrate under the conditions below, using

reactive DC sputtering are shown.

[0052] Film forming condition

Applied electric power: 4 kW

Sputtering gas: Ar + N_2 (N_2 ratio: 10 to 90 volume %)

Sputtering gas pressure: 2 mTorr

Sputtering target: TiN target

Substrate temperature: approximately 70 °C

Film thickness: 10 nm

From Fig. 2, the resistivity of when the N_2 ratio, the mixing ratio as the sputtering gas, is 55.5 % (flow rate of N_2: 25 SCC M$\fallingdotseq 4.2 \times 10^{-7}$ m^3/sec, flow rate of Ar: 20 SCC M$\fallingdotseq 3.3 \times 10^{-7}$ m^3/sec), for example, is 2.2×10^{-4} Ω cm, absorption coefficient of visible light of wavelength 405 nm is 1.13. In addition, from Fig. 2, it can be seen that the absorption coefficient increases and the transmissivity of visible light decreases when the mixing rate of N_2 gas in the sputtering gas is low, and the resistivity is high when the mixing rate of N_2 gas in the sputtering gas is high.

[0053] Because of these, in order to form a TiN film excellent in resistivity and transmissivity of visible light, it is preferable that the mixing rate of N_2 gas in the sputtering gas is approximately 40 to 70 volume %.

[0054] In addition, when film forming under the above-described conditions (the mixing rate of N_2 gas is 5.5 wt.%) is performed with different film thickness, results shown in Table 1 are obtained.

[0055]

[Table 1]

Film thickness (nm)	Transmissivity (%)
5	69.2
10	54.1
15	43.4
20	35.5

[0056] Considering Table 1 and that the visible light average transmissivity at practical level is 50 %, it is preferable that the film thickness of the TiN film is 10 nm or less. In addition, in the case where the film thickness of the TiN film is thinner than 3 nm, it doesn't function enough as an anode. Therefore, it is preferable that the thickness of the TiN film is 3 nm or more.

[0057] Consequently, for these reasons, it is preferable that the thickness of the TiN film is approximately 3 to 10 nm.

[0058] Then, an organic EL layer 9 is formed on the above-described first electrode 3 which is the anode. The organic EL layer 9 is formed by forming a hole transporting layer 4, a light-emitting layer 5 and an electron transporting layer 6 in this order, using vacuum deposition. Here, the hole transporting layer 4 is formed by depositing m-HTDATA, for example. The light-emitting layer 5 is formed by depositing α-NPD, for example. And, the electron transporting layer 6 is formed by depositing AlQ_3, for example. The thickness of the organic EL layer 9 is 150 nm, for example.

[0059] Next, on the organic EL layer 9 formed as the above, an AlTi film, for example, as a second electronde 7 which is the cathode is formed to a thickness of 100 nm by sputtering.

[0060] Lastly, a protecting layer 8 with a thickness of 1000 nm made of SiN, for example, is formed by sputtering so as to cover each layer formed as the above.

[0061] Specifically, an organic EL element shown in Fig. 3 can be manufactured in the following way, for example. An organic EL element 11 shown in Fig. 3 is another configuration example applying the present invention.

[0062] First, in order to manufacture a simple matrix of 30 mm × 36 mm with 12 groups of RGB stripes, 36 TiN transparent electrodes whose thickness is approximately 10 nm are formed as an anode 13 by reactive DC sputtering with a width of 1.15 mm and the spacing 0.1 mm on a film-like plastic substrate 12 of 53 mm × 53 mm, and an insulating layer 14 of SiO_2 with a width of 0.5 mm and the spacing 1.0 mm is formed by vacuum deposition on the column side. Therefore, the light-emitting region of a cell for forming one organic EL element is 1.0 mm × 1.15 mm, and the aperture ratio is 60.8 %.

[0063] Next, on the TiN transparent electrode, m-MTDATA (4, 4', 4" –tris (3-methylphenylphenylamino) triphenylamino) whose structural formula is shown in Fig. 4 is deposited as a hole transporting layer 15a on the whole including TiN to a thickness of 30 nm under vacuum, by vacuum deposition with the deposition speed of 0.2 to 0.4 nm/sec, using a mask whose apertural area formation is 40.0 mm × 48.0 mm.

[0064] Next, on the hole transporting layer 15a, α-NPD (α-naphtylphenyldiamine) whose structural formula is shown in Fig. 5 is deposited as a hole transporting light-emitting layer 15b to a thickness of 50 nm under vacuum, by vacuum deposition with the deposition speed of 0.2 to 0.4 nm/sec, so that a luminous hole transporting layer 15 with a two-layer structure is formed.

[0065] Next, on the hole transporting layer 15, changing the mask to the one with 12 striped apertures whose formation is 1.16 mm × 49 mm, phenanthroline derivative whose structural formula is shown in Fig. 6, bathocuproine (2, 9-dimethyl-4,

7-diphenyl-1, 10-phenanthroline) whose structural formula is shown in Fig. 7, for example, is deposited in a striped pattern of 1.15 mm × 48.0 mm which is a light-emitting region of the TiN transparent electrode, on the TiN transparent electrode to a thickness of 20 nm under vacuum, by vacuum deposition with the deposition speed of 0.2 to 0.4 nm/sec.

[0066] Next, on the hole transporting layer 15, changing the mask to the one with 12 striped apertures whose formation is 1.16 mm × 49 mm, BSB-BCN whose structural formula is shown in Fig. 8 is deposited as an electron transporting red light-emitting material layer 17 in a striped pattern of 1.15 mm × 48.0 mm which is a light-emitting region of the anode, on the TiN transparent electrode to a thickness of 20 nm under vacuum, by vacuum deposition with the deposition speed of 0.2 to 0.4 nm/sec.

[0067] After that, changing the mask to the one whose aperture formation is 40.0 mm × 48.0 mm, Alq_3 (8-hydroxy quinoline aluminum) whose structural formula is shown in Fig. 9 is deposited as an electron transporting layer or an electron transporting light-emitting material layer 18 to a thickness of 40 nm under vacuum by vacuum deposition with the deposition speed of 0.2 to 0.4 nm/sec.

[0068] Next, changing the mask to the one whose aperture area is 1.16 mm × 49 mm, Al-Li19a (aluminum-lithium alloy: Li concentration approximately 1 mol %) is deposited as a cathode 19 to a thickness of approximately 0.5 nm, and Al19b is deposited to a thickness of approximately 200 nm by vacuum deposition, so that an organic EL element 11 which is RGB-capable as shown in Fig. 3 can be manufactured.

[0069] As for the organic EL element 11, by applying a direct-current voltage between the anode 13 and the cathode 19 selectively, holes which are injected from the anode 13 move through the hole transporting layer 15 and electrons which are injected from the cathode 19 move through the electron transporting layer 18, and they reach the light-emitting layers 15b, 17 and 18 respectively. As a result, recombination of electrons and holes arises in the light-emitting layers 15b, 17 and 18, and light emission of the predetermined wavelength is generated from here. That is, blue light-emission is obtained in the light-emitting region having bathocuproine which functions as a hole block layer 16. In addition, green light-emission which is light-emission from Alq_3 as an electron transporting light-emitting material is obtained in the light-emitting part without bathocuproine. And, red light-emission is obtained from the striped part where BSB-BCN is deposited between α-NPD and Alq_3.

[0070]

[Effect of the Invention] As described above in detail, an organic electroluminescence element (hereinafter called organic EL element) of the present invention has a first

electrode, an organic electroluminescence layer (hereinafter called organic EL layer) having a light-emitting material made of an organic compound and a second electrode on a substrate in this order, and the substrate is a film-like plastic substrate, and the first electrode is an electrode made of nitride and has translucency.

[0071] Since the organic EL element of the present invention uses a film-like plastic substrate, it can be much lighter, compared to an organic EL element using a conventional glass substrate.

[0072] In addition, since the organic EL element of the present invention uses a film-like plastic substrate having flexibility, it has good flexibility.

[0073] And, since the organic EL element of the present invention uses a film-like plastic substrate which is excellent in impact resistance against a shock such as fall, the impact resistance can be greatly improved.

[0074] Furthermore, since this organic EL element uses nitride as the anode material, there is no penetration and invasion of oxygen and indium in the organic EL layer from the anode material. That is, the organic EL layer doesn't deteriorate by penetration and invasion of oxygen and indium in the organic EL layer from the anode material.

[0075] Therefore, according to the present invention, an organic EL element which is light and excellent in durability, having flexibility and impact resistance, and capable of preventing the deterioration of an organic EL layer can be provided.

[Brief Description of Drawings]

Fig. 1 is a vertical cross-sectional view showing a configuration example of an organic EL element applying the present invention.

Fig. 2 is a diagram showing characteristics concerning resistivity and absorption coefficient of a TiN film.

Fig. 3 is a vertical cross-sectional view showing another configuration example of an organic EL element applying the present invention.

Fig. 4 is a diagram showing a structural formula of m-MTDATA.

Fig. 5 is a diagram showing a structural formula of α-NPD.

Fig. 6 is a diagram showing a structural formula of phenanthroline derivative.

Fig. 7 is a diagram showing a structural formula of bathocuproine.

Fig. 8 is a diagram showing a structural formula of BSB-BCN.

Fig. 9 is a diagram showing a structural formula of Alq_3.

[Description of Symbols]

1: organic EL element

2: film-like plastic substrate

3: anode

4: hole transporting layer
5: light-emitting layer
6: electron transporting layer
7: cathode
8: protecting layer
9: organic EL layer

[Fig. 6]
(In this general formula, R^1 to R^8 show a hydrogen atom, an alkyl group of substitution or unsubstitution, an aryl group of substitution or unsubstitution, amino group of substitution or unsubstitution, a halogen atom, a nitro group, a cyano group, or a hydrogen group.)

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